

REMARKS

This is a response under 37 CFR §1.116. The remarks herein, to the extent they were not presented earlier, are now presented because they are necessitated by the arguments made by the Examiner in the last office action. Since this response is being filed within two months of the mailing date of the final rejection, an advisory action is respectfully requested. Claims 47-64 are in this application. Claims 1-46 have been cancelled.

Applicant requests the Examiner to initial the PTO Form 1449 filed on January 19, 2006 (and received by the PTO on January 23, 2006), and return a copy of the initialed 1449 Form to applicant.

The Examiner rejected claims 47 and 49-50 under 35 U.S.C. §103(a) as being unpatentable over Tseng (U.S. Patent No. 5,741,741). For the reasons set forth below, applicant respectfully traverses this rejection.

Claim 47 recites:

“forming a layer of insulation material over a semiconductor structure, the layer of insulation material having a top surface;

“performing a first etch of a first region of the top surface of the layer of insulation material without etching a second region of the top surface of the layer of insulation material, the first etch forming a plurality of openings in the layer of insulation material, the plurality of openings having depths and bottom surfaces; and

“simultaneously performing a second etch of the second region of the top surface of the layer of insulation material and the bottom surface of each opening, the second etch substantially increasing the depths of the openings to form a plurality of trenches, each trench having a bottom surface with a length that is significantly greater than a width.”

The Tseng reference teaches a three-step process. In the first step, a number of trenches 13 are formed in insulating layer 16. As shown in FIGS. 1-3 of Tseng, a thick insulating layer 16 is formed on a number of conducting traces 14,

followed by the formation of a hard mask 18 and an overlying layer of photoresist 20. The resist layer 20 is then patterned. Next, the hard mask 18 is etched. Following this, insulating layer 16 is etched to form the trenches 13. (See also column 5, line 14 to column 6, line 21.)

In the second step, a number of via/plug openings are etched in the bottom surfaces of the trenches 13 to expose select regions on the top surfaces of the conducting traces 14. As shown in FIGS. 4-8 of Tseng, patterned resist layer 20 is laterally etched to form patterned resist layer 20' which, in turn, exposes more of the hard mask 18. The newly exposed regions of hard mask 18 are then etched. (See column 6, lines 33-50 of Tseng.)

Following this, resist layer 20' is removed, and replaced by a patterned resist layer 24. As taught by Tseng, patterned resist layer 24 has "openings over the trenches 13' where the T-shaped metal plug contact openings are to be formed while masking from etching the remaining portions of the trenches." (See column 6, lines 53-57 of Tseng.)

After this, the plug contact openings 17 are anisotropically and selectively plasma etched to expose the surface of the first level of interconnections 14. (See from column 6, lines 66 to column 7, lines 3 of Tseng.) Thus, only select regions of the bottom surfaces of the trenches 13 are etched to form plug contact openings 17 which, in turn, expose select regions on the top surfaces of the conducting traces 14.

In the third step, a layer of metal 30 is deposited to fill up the trenches 13 and the plug contact openings 17, and then planarized to form T-shaped metal plug contacts 30' in the plug contact openings 17, and conducting lines 30 in the trenches 13. (See FIGS. 9-10 of Tseng.) Thus, in summary, Tseng teaches a two-step etch process where the first etch forms a number of trenches, and the second etch forms a number of plug contact openings in select regions of the bottom surfaces of the trenches.

In rejecting claim 47, the Examiner pointed to the formation of insulating layer 16 shown in FIG. 1 of Tseng to be the "forming a layer of insulation material" element, and the formation of trenches 13 shown in FIG. 3 of Tseng to be the "performing a first etch" element. In addition, although the Tseng reference teaches the formation of plug contact openings 17 shown in FIG. 7 of Tseng, the Examiner noted that the Tseng reference fails to teach that the plug contact openings 17 are trenches. As a result, the Tseng reference does not teach the "simultaneously performing a second etch" element required by claim 47.

However, the Examiner appeared to argued that it would be obvious to form plug contact openings 17 as trenches because a trench is merely an optimized shape of a plug contact opening, which can be produced through experimentation by a routine variation of the parameters (dimensions). "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456 (CCPA 1955). (See also MPEP §2144.05(II).)

However, a prima facie case of obviousness can be rebutted "by showing that the claimed range achieves unexpected results relative to the prior art range." In re Woodruff, 919 F.2d 1575 (Fed. Cir. 1990). A prima facie case of obviousness can also be rebutted "by showing that the art, in any material respect, teaches away from the claimed invention." In re Geisler, 116 F.3d 1465, 1471 (Fed. Cir. 1997). (See also MPEP §2144.05(III).)

With respect to teaching away, it is well known in the art that a trench, which has a length that is significantly greater than a width, and a contact/via opening are separate and distinct structures. Contact and via openings are used to form contacts and vias while, in the Tseng case, trenches are used to form metal traces. Vias, in turn, are used to electrically interconnect metal traces that lie in different metal layers.

However, one skilled in the art would not be motivated to form contact/via openings as trenches because trench-sized contact/via openings would severely limit how close together adjacent metal traces can be placed to each other. For example, a first metal trace and a second metal trace, which lies orthogonal to the first metal trace and in an overlying metal layer, can be electrically connected together by a via that contacts the metal traces at the point of intersection.

In this example, not only would a trench-shaped via provide no apparent advantage, but it would provide the severe disadvantage of requiring other metal traces in the same metal layers to be routed around the trench-shaped via to avoid unwanted connections. In other words, a third metal trace that lies in the same metal layer as the first metal trace would have to be routed around a trench-shaped via to avoid contacting the trench-shaped via.

A shape which provides no advantage over the prior art, but instead provides a severe disadvantage, can not be an optimum shape, and would not result from a routine variation of the parameters (dimensions). Thus, a trench can not be the optimized shape of a plug contact opening. Therefore, since the Tseng reference fails to teach that the plug contact openings 17 are trenches, and trenches are not the optimized shape of the plug contact openings 17, claim 47 is patentable over Tseng. In addition, since claims 49-50 depend from claim 47, claims 49-50 are patentable over Tseng for the same reasons as claim 47.

The Examiner also rejected claims 48, 51, 53, 55-56, and 62 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Chittipeddi et al. (U.S. Patent No. 6,417,087). For the reasons set forth below, applicant respectfully traverses this rejection.

Claim 48 recites:

"wherein the bottom surface of each of a number of trenches exposes a same conductive structure."

In rejecting the claims, the Examiner acknowledged that the Tseng reference does not teach that the bottom surface of each of the plug contact openings 17 exposes the same conductive structure as required by claim 48. However, the Examiner argued that the missing limitations are well known as shown by FIG. 2 of the Chittipeddi reference.

As shown in FIGS. 1-3, the Chittipeddi reference teaches a bond pad 27 that is electrically connected to a conductive film 5 through a number of vias 19. As a result, applicant assumes the Examiner has argued that it would be obvious to form the vias 19 of the Chittipeddi reference in lieu of a single plug contact opening 17 of the Tseng reference.

However, even if the references were combined, neither of the references teaches or suggests that the bottom surfaces of a number of trenches expose the same conductive structure. As noted above, the Examiner acknowledged that the plug contact openings 17 of the Tseng reference are not formed as trenches. In addition, as shown in the plan view of FIG. 3 of Chittipeddi, none of the vias 19 are formed as trenches. Further, as discussed above, a trench can not be the optimized shape of a plug contact opening 17.

Thus, since Tseng does not teach or suggest that the plug contact openings 17 are formed as trenches, Chittipeddi does not teach or suggest that the vias 19 are formed as trenches, and a trench can not be the optimized shape of a plug contact opening 17, there is nothing that teaches or suggests that the bottom surfaces of the trenches expose the same conductive structure as required by claim 48. As a result, claim 48 is patentable over Tseng in view of Chittipeddi.

After the trenches are filled up with metal to form a number of fingers, claim 53 recites:

“wherein the bottom surface of each of a number of fingers contact a same conductive structure.”

Thus, claim 53 is patentable over Tseng in view of Chittipeddi for the same reasons as claim 48.

Claim 55 recites "wherein the conductive structure is a top surface of a via," and claim 56 recites "wherein the conductive structure is a top surface of a contact." However, neither the T-shaped metal plug contacts 30' formed in the plug contact openings 17, nor the vias 19 are formed to contact a via or a contact. As shown in FIG. 10 of Tseng, the T-shaped metal plug contacts 30' are connected to conducting layers 14, while the vias 19 shown in FIG. 2 of Chittipeddi are connected to conductive film 5.

The Examiner argued that it would be obvious to make a connection to the top surface of a via if a connection is to be made to only a portion of a lower level conductor. Applicant respectfully does not understand the Examiner's argument as the T-shaped metal plug contacts 30' and the vias 19 only make a connection to a portion of conducting layers 14 and conducting film 5, respectively. Thus, since neither the Tseng nor Chittipeddi references teach the required limitations, claims 55 and 56 are patentable over Tseng in view of Chittipeddi.

Claim 51 recites:

"forming a conductive layer on the layer of insulation material, the conductive layer filling up the trenches; and

"planarizing the conductive layer to form a single conductive region, the single conductive region in the trenches forming a plurality of fingers, each finger having a bottom surface with a length that is significantly greater than a width."

Claim 62 recites the same limitations.

As noted above, Tseng teaches depositing a layer of metal 30 to fill up the trenches 13 and the plug contact openings 17, and then planarizing to form T-shaped metal plug contacts 30' in the plug contact openings 17, and conducting lines 30 in the trenches 13. (See FIGS. 9-10 of Tseng.) However, as further noted

above, Tseng does not teach or suggest forming the plug contact openings 17 as trenches.

As additionally noted above, the Chittipeddi reference does not teach or suggest forming vias 19 as trenches. As a result, claim 47 is patentable over Tseng in view of Chittipeddi. Thus, since claims 51 and 62 depend either directly or indirectly from claim 47, claims 51 and 62 are patentable over Tseng in view of Chittipeddi for the same reasons that claim 47 is patentable over Tseng in view of Chittipeddi.

The Examiner further rejected claim 52 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Chittipeddi et al. and further in view of Adams (U.S. Patent No. 6,566,242). Claim 52 depends indirectly from claim 47, and the Examiner cited the Adams reference as teaching a barrier layer, seed layer, and copper layer.

As noted above, claim 47 is patentable over Tseng in view of Chittipeddi. In addition, applicant has been unable to find any discussion in Adams that teaches or suggests forming the plug contact openings 17 of Tseng as trenches. Thus, since neither the Tseng, Chittipeddi, nor Adams reference teach or suggest forming contact/via openings as trenches, claim 52 is patentable over Tseng in view of Chittipeddi and further in view of Adams.

The Examiner also rejected claims 54 and 63-64 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Chittipeddi et al. and further in view of Yu (U.S. Patent No. 5,952,704). Claims 54 and 63-64 depend indirectly from claim 47, and the Examiner cited the Yu reference as teaching loops that lie in the same plane.

As noted above, claim 47 is patentable over Tseng in view of Chittipeddi. In addition, applicant has been unable to find any discussion in Yu that teaches or suggests forming the plug contact openings 17 of Tseng as trenches. Thus, since neither the Tseng, Chittipeddi, nor Yu reference teach or suggest forming

contact/via openings as trenches, claim 47 is patentable over Tseng in view of Chittipeddi and further in view of Yu. As a result, claims 54 and 63-64 are patentable over Tseng in view of Chittipeddi and further in view of Yu for the same reasons as claim 47.

The Examiner also rejected claims 57-58 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara et al. (U.S. Patent No. 5,976,972). As noted above, claim 47 is patentable over Tseng since the Tseng reference fails to teach that the plug contact openings 17 are trenches, and trenches can not be the optimized shape of the plug contact openings 17.

Further, as shown in FIGS. 9A-9B of Inohara, the contact holes 48 are not formed as trenches. In addition, one skilled in the art would not be motivated to form the contact holes 48 of Inohara as trenches because, as noted above, trench-sized contact holes 48 would severely limit how close together adjacent metal traces can be placed to each other. As a result, a trench can not be the optimized shape of the contact hole 48. Thus, since neither the Tseng nor Inohara reference teaches or suggests forming contact/via openings as trenches, claim 47 is patentable over Tseng in view Inohara. Claims 57-58 depend either directly or indirectly from claim 47, and are therefore patentable over Tseng in view Inohara for the same reasons as claim 47.

With further respect to claim 57, this claim recites:

“wherein the bottom surface of a trench exposes an area of a conductive structure and an area of the insulation material, the area of the insulation material being substantially greater than the area of the conductive structure.”

In rejecting the claims, the Examiner pointed to the contact holes 48 shown in FIGS. 9A-9B of the Inohara reference. However, as shown in FIGS. 9A-9B of Inohara, the area of the insulating material exposed by a contact hole 48 is not

substantially greater than the area of a conductive structure exposed by the contact hole 48 as required by claim 57.

The Examiner appeared to acknowledge that the Inohara reference fails to teach this limitation, stating that "depending on the size of the contact hole more or less of the insulation material would be exposed." Applicant notes, however, that a substantially larger contact hole 48 would have to be formed before the area of the exposed insulating material would be substantially greater than the exposed area of the conductive structure.

The Examiner provided no indication of why one skilled in the art would be motivated to substantially increase the size of a contact hole 48 other than to indicate that the dimension arguments of claim 47 also apply. However, as noted above, a trench can not be the optimized shape of the contact hole 48. As a result, claim 57 is patentable over Tseng in view of Inohara for this additional reason.

The Examiner also rejected claims 59-60 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara et al. and further in view of Chittipeddi. Claim 59 recites the same limitations as claims 51 and 62. Claims 59-60 depend indirectly from claim 47. As noted above, claim 47 is patentable over Tseng in view of Chittipeddi, and is also patentable over Tseng in view of Inohara. As a result, claim 47 is patentable over Tseng in view of Inohara and further in view of Chittipeddi. Thus, claims 59-60 are patentable over Tseng in view of Inohara and further in view of Chittipeddi for the same reasons as claim 47.

The Examiner additionally rejected claim 61 under 35 U.S.C. §103(a) as being unpatentable over Tseng in view of Inohara et al. and further in view of Chittipeddi and Yu. Claim 61 depends indirectly from claim 47. As noted above, claim 47 is patentable over Tseng in view of Inohara and further in view of Chittipeddi. As further noted above, claim 47 is patentable over Tseng in view of Chittipeddi and further in view of Yu. Thus, claim 47 is patentable over Tseng in view of Inohara and further in view of Chittipeddi and Yu. As a result, claim 61 is patentable over

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Tseng in view of Inohara and further in view of Chittipeddi and Yu for the same reasons as claim 47.

Thus, for the foregoing reasons, it is submitted that the application is in a condition for allowance. Therefore, the Examiner's early re-examination and reconsideration are respectively requested.

Respectfully submitted,

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